Luxury lodge goes off-grid

CASE STUDY

Key features

- 3.2 kW micro hydro turbine generates lodge's electricity in a stand alone power system
- 27 kW back-up diesel generator

Key benefits

- Less expensive option than connecting to electricity network
- Minimises greenhouse gas emissions
- Environmental benefits align with company's environmental values and brand

Connecting to the electricity network was not a viable option for a luxury lodge in the Waihopai Valley, in Marlborough. Instead, the owners of this exclusive tourist destination saw the opportunity to install a hydro generator to power their first-class guest experience with clean renewable electricity.

Glazebrook Lodge provides its guests with an opportunity to visit an unspoilt part of backcountry New Zealand, but stay in luxury surroundings. Rather than running a cable to connect to the electricity network, which was going to cost in excess of $900,000, the lodge owners invested in a much more cost-effective and environmentally-friendly form of distributed generation on their own property.

Steve Smith, the New Zealand general manager of the Westervelt company which owns the lodge, knew that long term sustainability, secure electricity supply, and environmental responsibility were cornerstone priorities for the company. Generating their own electricity with a hydro turbine matched the company's environmental vision.

"There weren't many options at Glazebrook, but we knew that we didn't want to just run a diesel generator for our electricity – that just wasn't attractive or consistent with our company values."

Being 'independent' and having a small environmental footprint were important at the lodge. "Businesses like ours need to look beyond the basic options," says Steve. "We needed an electricity supply system that would allow our company to run its business into the future. Every time the price of diesel increases, the initial upfront costs becomes relatively cheaper."

The weir, or dam, used to temporarily divert a small portion of the stream into the penstock.

The building that houses the hydro turbine, diesel generator, and batteries.

The generating system

Glazebrook Lodge selected Genkit Nelson Ltd to install a micro-hydro scheme at the lodge, which has enabled them to become energy self-sufficient using largely renewable energy. The hydro turbine has an output of 3.25 kilowatts (kW), and generates over 28,000 kilowatt hours (kWh) each year. That is enough to power over three average New Zealand houses.

The turbine charges a battery bank, which stores the electrical energy until it is used. An inverter converts the electricity into AC electricity, so it can be used in the appliances in the lodge. A diesel generator is there for back-up, in case the batteries run down, or the hydro generator stops operating.

Technical specifications

The Glazebrook micro-hydro system has the following features:

- A 3.2 kW hydro turbine
- A small weir which is 200 mm deep
- A penstock which is 2.5 km long, and 110 mm in diameter
- 48 x 100 amp/hour batteries
- A 27 kW diesel generator
- 4 x 3 kW inverters

The hydro scheme

The hydro scheme at Glazebrook uses a purpose-built weir (a small dam) upstream of the lodge. The weir is used to store a small amount of water, and to temporarily divert it into a long penstock (pipe) that takes the water over 2 km downstream to the generator and battery bank.

With all micro-hydro schemes, the system must not adversely affect the flow and volume of the stream. It is recommended that no more than 50% of the flow is diverted when the stream is at its lowest. This ensures that fish and aquatic invertebrates can still freely migrate and use the water resource. The system at Glazebrook Lodge takes less than 10% of the flow, when the stream is at its lowest.

To reduce environmental impact of the scheme, a small ‘fish ladder’ has been constructed to provide safe passage for migratory fish, which was a condition of their resource consent. Power output could possibly have been increased by moving the weir further up the stream, but diverting more flow into the turbine could have adversely affected the fish life in the stream.

“Small-scale distributed generation projects like this can produce reliable renewable electricity, with only minor environmental effects, and these can usually be mitigated. Because of the fish ladder, the scheme doesn’t present a barrier to the fish,” remarked Steve.

The penstock

The penstock carries the water from the weir down to the generator below. The pipe is 110 mm in diameter, and is buried underground all the way down to the powerhouse, where it passes through the turbine, before being returned to the same stream that it was diverted from. It is important to ensure that water used in micro-hydro schemes is returned to the same catchment it was taken from, in order to reduce environmental impacts.

The powershed

Below the lodge, a shed houses the micro-hydro turbine, the battery bank, the diesel generator and the inverter and controllers. Batteries can emit flammable gasses and fumes, and for this reason should be situated away from electrical equipment that can spark or produce heat.

The hydro turbine

When water from the penstock flows through the 4 kW 3-phase generator, a nominal 3.25 kW of power is generated to charge the battery bank. The turbine is mounted on top of an air vent, which allows the water to return to the stream directly below the turbine.

If Steve had to do it again, he says he would have installed a larger hydro generator. “It would be great to be 100% renewable, rather than having to rely on the diesel back-up. It may have been difficult, given the electricity demand profile of the lodge, but we could have looked at smarter and more efficient appliances to reduce peak demand. This is something I would look into next time.”

The turbine operates with a controller, which has two functions. It changes the 3-phase output from the generator into single phase at 240 V. It also monitors the speed of the turbine, and can dump excess energy into an element mounted above the controller.

The battery bank

The batteries in this system are capable of supplying the lodge with electricity for approximately 36 hours, without charge. There are 48 1000 amp/hour battery cells. Because of the potential for fumes to be emitted from the batteries, a vent fan pressurises the room when the batteries are being charged.

How much electricity will a hydro scheme generate?

Potential for hydro generation depends on the specific site. First, work out the flow and head of the site. Flow is usually measured in litres per second. If a 10 L bucket takes 1 second to fill, the flow is 10 L/s. Head is the vertical distance between where you take the water and the generator.

A simple calculation: flow (L/s) x head (m) x efficiency (%) x gravity constant (10) = power available (Watts). A rough guide is that micro-hydro turbines have an efficiency of about 50%, or 0.5.

For example: 10 L/s x 10 m x 0.5 x 10 = 500 W output

The amount of energy generated per day depends on the percentage of time the system operates at full output. This percentage will vary depending on the system design and the site, and will likely vary between 50% and 70% for micro-scale schemes.

For example: 500 W x 24 hours x 0.6 = 7.2 kWh per day

Talk to an expert supplier or installer for more information and assistance with this.

The inverter and electrics

The inverters perform the essential task of converting the electricity from the battery bank (direct current) into useful electricity for the lodge (alternating current). There are four inverters, each with three kilowatts of output. Next to the inverters are the distribution board, and controller.

Control panel inside the lodge.

Backup diesel generator

Because a secure electricity supply is vital for the lodge, there is a diesel backup generator which will charge the batteries, if the hydro systems should fail. A three cylinder 27 kW air-cooled generator has been used.

The back-up diesel generator, fuel storage, and micro hydro turbine.

Results

Genkit Nelson Ltd installed the entire system, and it is certified to New Zealand and Australian Standards.

The system provides cost-effective power for the lodge, and is running smoothly. However, being remote can present challenges. “Because we are so remote, any teething problems can be more difficult to fix,” Steve says.

Glazebrook is a good example of using renewable energy technologies to avoid the high costs of connecting to the electricity network and the ongoing costs of using diesel to generate electricity. Businesses like the lodge can utilise renewable electricity options to generate their own cost-effective electricity, and support their values and brand.

All micro-hydro systems are different, and must be designed according to the site, the resources available, and to the electricity demand. These types of systems can be economically viable for many rural businesses or properties that have streams or rivers on their properties.

The entire installation cost around $300,000. About $40,000 was for laying the pipes, with the remainder for the electrics, turbine and resource consents.

Compared to the $900,000 cost of connecting to the electricity grid, plus the ongoing metered electricity costs, installing this system is an economically sound option, which provides largely free, renewable electricity for the life of the system.

Key steps for getting off the grid

If you are considering a stand-alone power system, there are some important steps to take.

Gather information. Get a number of different system quotes and use an experienced and qualified company. Ask your installer for references and visit the Sustainable Electricity Association of New Zealand’s website – www.seanz.org.nz

Get a quote for connecting your property to the electricity network. This will help you decide whether an off-grid system is viable option.

Get your system designed by an expert. To be effective, the system needs to meet the specific characteristics of your property – an expert can maximise productivity and minimise environmental impacts.

As a safety precaution, the battery bank is separated from the diesel generator and hydro turbine.

EECA enables organisations to increase their domestic and international competitiveness by adopting energy efficiency and renewable energy practices.

We work with businesses to identify the opportunities for energy management that are available to them and help them develop energy management action plans to make the most of these opportunities.

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We have a particular interest in:

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- developing the wood fuel industry.

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